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THE HISTORY AND WORK OF THE ARMY MEDICAL LIBRARY[1]

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THE celebration on November 16, 1936, of the centenary of the foundation of the Army Medical Library served to bring home to a large number of persons not engaged in work in the medical sciences the importance of this great collection of books. This celebration was attended by six or seven hundred representatives of universities, libraries and learned societies of the world, and cablegrams, letters and diplomas of honor were received from nearly 200 foreign institutions alone. These bodies joined in commemorating the establishment of what is now the largest collection of medical literature that the world has ever seen. The development of this mighty library in so short a time is a phenomenon in which American science and letters may take pride.

Established in 1836 by Surgeon General Lovell as a small number of reference medical texts for the use of his staff, it was in fact as well as in name "The Surgeon General's Library." The collection, hardly more extensive for some years than President Eliot's five-foot shelf of books, grew but slowly until, at the close of the Civil War, one of the greatest men of science our land has produced was placed in charge and given the congenial task of building up a great national medical library.

This man was Surgeon John Shaw Billings (1838–1913). When he took up his new work the library consisted only of 2,253 volumes (602 titles under 11 topical subdivisions). A catalogue of the collection was printed in 1865. Billings was given the sum of $80,000 left over from the hospital fund of the war, and wise Surgeon General Barnes likewise gave him a free hand. Billings had realized the need for such a library ever since he was a medical student at what is now the University of Cincinnati. Writing many years later he said:

[1] Read on December 30, 1936, at Brown University, Providence, R. I., before the joint session of the History of Science Society and the American Historical Association.

I became convinced of three things. The first was, that it involves a vast amount of time and labor to search through a thousand volumes of medical books and journals for items on a particular subject, and that the indexes of such books and journals can not always be relied on as a guide of their contents. The second is that there are in existence, somewhere, over 100,000 volumes of such medical books and journals, not counting pamphlets and reprints. And the third was, that while there was nowhere in the world a library which contained all medical literature, there was not in the United States any fairly good medical library, one in which a student might hope to find a large part of the literature relating to any medical subject, and that if one wished to do good bibliographical work to verify references given by European medical writers, or to make reasonably sure that one had before him all that had been seen or done by previous observers or experimenters on a given subject he must go to Europe and visit, not merely one, but several of the great capital cities in order to accomplish his desire.

With a gift for judging the value of books, an almost uncanny sense of where to find them and an orderly mind that enabled him properly to classify them, Billings was equipped by nature to be America's greatest bibliographer. He worked with extraordinary energy. In 1871 he produced his first catalogue, a three-volume work, each volume of the approximate size of the present Index Catalogue. But it was a catalogue only, and not comparable with the Index Catalogue soon to follow.

"Books," said Billings, "are properly compared to tools, of which the index is the handle." He had to have such a handle for his collection, already becoming unwieldy. So, in 1876, he published a "Specimen Fasciculus of a Catalogue of the National Medical Library, under the Direction of the Surgeon General, United States Army." This he submitted to the medical profession for criticisms and suggestions. Its style and arrangement were practically that of the Index Catalogue itself, another evidence of Billings's skill. Finally Congress was induced to appropriate funds for the publication of the work, and the first volume appeared in 1880.

Since such matters as typography and general arrangement of the contents had been settled in the "Specimen Fasciculus," there remained only the question of classification to be decided. "Following the general idea of a subject and author catalogue arranged in dictionary order in a single alphabet, the special subjects were featured by means of key titles or rubrics. After settling upon the main grand divisions, such as *Aneurism, Cancer, Tumors,* etc., and subdividing these, the subjects of lesser weight easily fell into their places by the simple device of finding the centers of gravity of the title in each case."[2]

[2] Garrison.

Dr. Billings saw clearly that he could not prepare complete bibliography of his subject, but rather bibliographical conspectus of the contents of a great library. Happily this proved so complete that became, for practical use, a working bibliography of medicine. Modern medical science was even then beginning to advance by leaps and bounds, its surface aspect constantly changing as it advanced, so that he saw at once that it would be impossible to adopt an arbitrary and fixed classification based on a definite scheme of nosology. Any such scheme would have been, like the average medical text-book of to-day, obsolete within a few years.

The appearance of the Index Catalogue marked an epoch in the development and improvement of medical literature, particularly in the United States. For the first time the literature was at hand in the most convenient and accessible form, that is, strictly alphabetically catalogued. The Index Catalogue has no equal. "Its preparation," said Osler, "is Gargantuan." In no other field of knowledge is there a work comparable to this, the world's standard of medical bibliography. No matter where medical research is undertaken, there must one have the Index Catalogue. It is as much used in Europe, Asia and South America as in our own continent. "Among catalogues," says Professor William Bulloch, F.R.S., "it is regarded by the authorities of the British Museum as the greatest ever achieved."

The First Series of the Index Catalogue, 16 volumes, was completed in 1895 with the end of the alphabet, and Billings retired to accept the chair of hygiene at the University of Pennsylvania. Subsequently he was given charge of the consolidation of the three public libraries of New York City and the cataloguing of each, becoming, when the present building was completed, its librarian. A Second Series of the catalogue was begun in 1896 under the careful redaction of Billings's assistant, Dr. Robert Fletcher (1823–1912). This (26 volumes) was finished in 1916 and the Third Series of 10 volumes appeared between 1918 and 1932. The first volume of the Fourth Series was issued last spring and the second volume is now in press.

In 1879 Billings established another monumental work, the Index Medicus, a monthly classified record of the current medical literature of the world. The editorial management of the Index Medicus was principally in the hands of Dr. Fletcher, likewise a noted bibliographer. The Index Medicus consisted, from the start, of a printed monthly fasciculus, giving the medical literature of the preceding month carefully arranged as to subject-rubrics. The classification, as covering a smaller body of material, was more general than that of the Index Catalogue.

Never a government publication, the Index Medicus

ways had great difficulty in paying for itself. It as expensive to publish and, though of the greatest e, the number of subscribers was necessarily limited, ing chiefly medical libraries. From 1879 to 1899 it as published successively in New York, Detroit, Boson and Washington. Finally its founders could no nger afford to continue it. In vain did such men as sler and Weir Mitchell plead with physicians to subribe. In Paris Professors Charles Richet and Marcel audoin issued Bibliographia Medica (3 volumes) om 1900 to 1902 as a replacement, but they too had give up. In 1903 the Carnegie Institution of Washgton took over the Index Medicus and carried its nancial losses until 1927, when the Index Medicus as merged with the Quarterly Cumulative Index founded 1916) of the American Medical Association. he combined periodical, the Quarterly Cumulative Inex Medicus, was published under the joint direction f the Army Medical Library and the American Medil Association until the end of 1931, when its connecon with the library ceased, and it became solely a ournal of the association. Except for two years spent Manila, Dr. Fielding Hudson Garrison (1870–1935) as the editor of the Index Medicus after it was taken ver by the Carnegie Institution.

With two such working tools as the Index Catalogue nd the Index Medicus the student of medical science an in a very few moments assemble the bibliography f a subject or an author. Each series of the Cataogue includes the complete alphabet from A to Z. Thus he merely looks in each for the subject or author f his choice and notes what the library has about or y each man. From the date of the volume of the last eries to the present, the annual volume of the Index Medicus are consulted and so it is a simple matter to omplete the bibliography. Each day the cards of the Army Medical Library are brought up to date so that he cataloguing of journal articles is done within a hort time of their receipt. The library is glad to quote he cards that have accumulated since the last issue of he Index Medicus thus rendering a bibliography as omplete as can be.

This is not the place to recount the struggles that the ibrary has had to obtain suitable quarters. The building now in use was erected in 1887 and was then adequate, but rapidly growing institutions, particularly ibraries, have a way of outgrowing their garments, o that now the building is so overcrowded that the tacks will bear no more weight. The engineers require hat when books are added others be withdrawn, so that he overflow fills the cellar and garret, and every other ook and corner. A new building must soon be provided, and this, we hope, will be of such size and contruction as to provide for expansion. Tentative plans have been drawn, and the century-old institution now but awaits Congressional consideration to provide the necessary funds—so small in these days of great financial figures.

A word as to the manner in which the Army Medical Library functions. It seeks, and its efforts have been crowned with no small success, to obtain everything worth while that is published anywhere in medical science. It receives an appropriation for purchases amounting to $20,000 per year, more or less, for Congress is at times more liberal than at others. All this goes into the acquisition of books and journals. Many authors and many institutions have long made it a practice to present a copy of each of their publications to the Army Medical Library, thus insuring their inclusion in the Index Catalogue. American law requires that two copies of each book copyrighted be sent to the Copyright Office, and one of these is preserved in the Library of Congress, while the other is, usually, turned over to some other governmental library. Most of these second copies of medical works are given to the Army Medical Library, though of late there has been a tendency for the Library of Congress to retain both copies of many purely medical works. Many institutions, receiving the Index Catalogue as a gift, reciprocate with gifts of their publications. So the $20,000 goes much further than would otherwise be possible. Moreover this sum does not have to cover such necessary expenses as salaries of personnel, postage, transportation costs, binding, etc. Thus it is possible for the library to receive upwards of 2,000 medical journals, the largest number of any medical library in the world.

All the books and practically all the material in the journals are indexed by subjects (the books by authors as well) and these entries soon make their appearance in the Index Catalogue. The material is available not only to local readers, but through the inter-library loan system to every student, physician and other reader in the country. So great has this inter-library loan department grown that now the library maintains its own mail wagon. Canada, too, benefits from this arrangement, and McGill University is one of the library's largest borrowers.

Everything in the library is available on loan except the rare material or what is unbound. The library's collection of rare medical books is one of the best in the world, and by far the best in America. It has an unusually complete statistical collection, the growth of about thirteen years and supplementing the splendid collection presented by the Prudential Life Insurance Company in 1923. There are medical manuscripts of great worth from the earliest day to the present. The document collection is, probably, the most complete of its kind.

The growth of this great collection of medical literature well illustrates the advantage of allowing a specialized library to develop along its own lines, without being hampered as must otherwise be the case, if merely a department of a great general library. The contrast between the national medical and law libraries well illustrates this. The Law Library of Congress was established in 1832, Congress requiring that it be maintained as a separate unit in "an apartment near the Library of Congress." This collection has frequently been neglected and has received but little money. Several law libraries in the United States are superior to the Law Library of Congress in some fields, while the Harvard Law Library is far larger and superior in every way, containing (1933) 435,000 volumes to the 275,000 of the Law Library of Congress. Contrast this with the growth of the Army Medical Library, which in twenty years passed the medical collections of the two largest general libraries in Europe, as well as those of America. "Undoubtedly," wrote the Law Librarian of Congress in 1933, "had the Law Library been independent from its foundation in 1832, the government would have possessed the best law library in the world to-day, instead of lagging behind, with many serious gaps in the collection." He therefore urged the friends of the Law Library of Congress to crystalize sentiment through the country to aid the Law Library to become as eminent in law as the Surgeon General's Library is in medicine.

In Europe one sees the disadvantages of merging a specialized library in a general collection. Billings himself always stressed this and showed that neither the medical collections of the Bibliothèque Nationale de France nor that of the British Museum has been able to develop as would otherwise have been possible. Medical writers make comparatively little use of these collections, preferring to use the special medical libraries of London and Paris, which are under the direction of medical bibliographers. I mention all this because from time to time one hears the suggestion that the Army Medical Library be added to the Library of Congress. The librarian of Congress, Dr. Putnam, recognizes the disadvantages of such a consolidation, adding that the Army Medical Library should "be administered by those familiar with that field."

I have sometimes thought that medical writers and students of the medical sciences in general are, bibliographically speaking, divided into two classes, those who know the Army Medical Library well, and those who do not know it at all. There are no half tones. Such folk are either in the high lights or the shadows, as it were. Those in other fields of learning may, perhaps far oftener than they may think, find material to their tastes and interests in this mighty collection of a million items. Its Index Catalogue is a tool that many other hands than those of physicians may use to good effect. It should be of interest to all men of letters, as well as of science, to know how to use a work which indexes practically everything of value in medical science, including every worthwhile article in every issue of every journal of every country in every language. Then, if not before, does one come to appreciate the soundness of dictum of the late Dr. William H. Welch, that the "Army Medical Library and its Index Catalogue are America's greatest gift to medicine."[3]

[3] The discussion of this paper was opened by Dr. Arnold C. Klebs, of Nyon, Switzerland, who said: "To us of the older generation who were privileged to visit under the inspiring guidance of Osler, when Billings, Fletcher and Garrison were still there, this great institution which later was so sympathetically and efficiently presided over by Colonel Hume, his report of past achievements and future problems makes a singular appeal. Does the present generation fully realize that we have there much more than a mere collection of books for use of the medical officers of the Army, much more even than a National Medical Library? In my wanderings abroad through numerous libraries I have always made it a point to ask the librarians how they advised those that were preparing medical monographs in the gathering of relevant material. The answer was invariably that the Index Catalogue was first consulted and often supplied all that was wanted. And when we consider that these rows of green books did not only grace the shelves by the side of the tomes of

WAVES AND CORPUSCLES IN QUANTUM PHYSICS[1]

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IT is a well-known fact that macroscopic phenomena, like the reflection, refraction, diffraction and the propagation along curved paths of matter and light rays, can be described by means of the corpuscular theory as well as by means of the wave theory. As to microscopic phenomena of atomic dimensions, one can apply the two classical models only to a certain degree, the limits of the corpuscular description being drawn by the Heisenberg uncertainty principle. Nevertheless, many physicists seem to prefer the corpuscular picture when they are asked as to what is happening "in reality."

Take for instance the usual statistical *corpuscular interpretation of Schrödinger's wave function* ψ; here $|\psi|^2=\rho$ is said to mean in reality the probability density of particles in space. To make this statistical distribution possible one has afterwards to resort to

[1] Address given at the Ohio Physics Club in Cincinnati, December, 1936.

rather artificial additional hypotheses. One has to endow the particles with a mysterious power of preferring regions where associated waves have their intensity maxima, in contradiction to the causal laws of mechanics. Sometimes the ψ-function seems to direct the particles even to regions where their kinetic energy would be negative and their velocity imaginary. On the other hand, one often applies a *wave interpretation of corpuscular phenomena:* It is said that the vibrational energy of matter or light waves within a vessel is confined to certain quantized levels, in contradiction to the continuous process of damping asked for by the wave theory.

I want to show here that these apparent contradictions are not at all inherent features of quantum theory, but are entirely the result of uncritical over-interpretations of the observed facts. Quantum theory in the contrary is based on the fundamental *complementarity* of waves and corpuscles, neither of them having a preference over the other, but either one describing the observed facts consistently without contradictions, as long as we confine ourselves to describing what we see. In order to become more critical towards a customary statement about the "real" nature of an observed process it is a good policy to compare the statement with a complementary statement in which the rôle of waves and corpuscles has been interchanged. If the antithesis obtained in this way proves to be unsatisfactory, then the original thesis ought to be considered as questionable, too. We are then better prepared to criticize both of them.

Let us recall that the general theory of relativity, too, started from a twofold interpretation of physical facts. The motion of a stone can be explained in two equivalent ways, either by the assumption of a field of gravity, or by reference to an accelerated system of coordinates. It would be quite a mistake, however, and contrary to the basic idea of relativity to apply the two explanations simultaneously and to ask, for instance, for the seat of gravitational forces *within* the accelerated frame. But it is just this kind of over-interpretation that can be found in the corpuscular interpretation of Schrödinger's wave function as well as in the aforementioned wave interpretation of selected energy levels.

Let us take the example of a *linear harmonic oscillator.* A piece of matter can be said to consist of microscopic oscillators if we observe it reacting *as though* it consisted of such oscillators. We might, for instance, illuminate the piece of matter with light waves of a given frequency ν. If the transmitted light shows, beside the original color ν, the new colors $\nu + \nu_0$ and $\nu - \nu_0$ (Raman-effect), and if, beside the original ray, a bundle of new diffracted light waves is emerging, then we may explain this effect in two independent ways, without contradictions.

(*a*) According to the wave theory of light, the color effect is produced by resonating matter which has a proper frequency ν_0. And the angular diffraction is explained by a certain continuous distribution of the resonating matter in space forming a cloud of density ρ_0 that serves as a Huyghens source of the secondary radiation $\nu \pm \nu_0$.

(*b*) The same optical effect of color change and diffraction can secondly be interpreted in corpuscular terms. The light is then supposed to consist of photons of energy E and of momentum P. The color effect indicates that the resonating matter consists of particles which exchange energy amounts E_0 with the photons so that the latter emerge with energies $E + E_0$ and $E - E_0$. Furthermore, the matter particles transmit momentum to the photons P and deflect them from their original direction. An analysis of the angular intensity distribution of the diffracted photons would tell us now how many particles have the momentum p and how many have the other momenta $p', p'' \cdot \cdot$, assuming that matter particles change their momentum from p' to p'' with a probability proportional to the product $\sigma(p') \cdot \sigma(p'')$, where $\sigma(p)$ is the *abundance* of various momenta p in the assembly of particles.

Either explanation is self-consistent. But it would be unreasonable to fuse them into one inconsistent idea. If we receive an optical signal reading "Camels," we can interpret it consistently in two ways. Either we assume the signal to come from a Bedouin in the desert, or from a smoker of cigarettes in America. But nobody would reasonably infer that the sender is an American smoker who is located in the desert. Likewise, it is unreasonable to infer that the matter particles which were introduced as the hypothetical source of corpuscular transmissions of energy $\pm E_0$ (first interpretation of the signal) are located in space in a manner described by the vibrating density ρ_0 (second interpretation). Nor would it be sensible to assume that the resonating wave density ρ_0 which was introduced as the hypothetical source of a wave radiation $\nu \pm \nu_0$ (second interpretation) changes its vibrational energy suddenly by such amounts E_0 as were introduced in order to explain the optical effect in a corpuscular way (first interpretation).

Over-interpretations like this and the attempts to fuse contradictory ideas have become the source of

the old classical bibliographers such as Gesner and Haller in European lands, but extended into the Far East and Far South, we could not resist a feeling of pride and warm admiration for the organizing genius of Billings, the fastidious classifier that was Fletcher, and the historical sensibilities of a Garrison, who had created an instrument of such far-reaching potentiality. Truly if there is one unifying emotion capable of bringing together a much split-up profession it might be aroused by this great achievement and its continuance in the future.''

many difficulties that have worried the students of quantum theory. This applies, for instance, to the ***apparent failure of causality*** in microphysics. A train of parallel light passing a small disk of microscopic dimensions (we could just as well use our former example of an oscillator) chooses to diffract its photons through a bundle of directions as though the photons had knowledge of the interference rules of waves. The photons, instead of going straight ahead, disregard the laws of causality and follow the guidance of a wave function; this is the current opinion. The paradox and its philosophical consequences disappear, however, if we describe the diffraction by a disk (or oscillator) consistently in pure wave or in pure corpuscular terms. The wave theory of light considers the disk of radius r as the Huyghens source of secondary waves. The density function of the disk is $\rho \begin{matrix} = \text{const. inside} \\ = 0 \text{ outside} \end{matrix} \Big\}$ of the radius r. The corpuscular theory explains the same phenomenon by means of photons of momentum P. It then has to describe the disk in corpuscular terms as well. Instead of having the density $\rho(r)$ as the Huyghens source of waves, the disk is now to be represented as an assembly of particles, in which various momenta p are present with an abundance $\sigma(p)$. The diffraction is explained by collisions between the photons and the matter particles which exchange their energies and momenta according to the causal conservation laws of mechanics, the number of transitions of the matter particles from p' to p'' being proportional to $\sigma(p') \cdot \sigma(p'')$. In the wave description disks of various shapes and sizes differ by their density distribution $\rho(r)$. From the corpuscular point of view various disks differ with respect to their spectrum $\sigma(p)$ (abundance function) of momenta. But it would be a violation of the basic idea of quantum theory to say that particles of matter with their distribution of momenta $\sigma(p)$ are located preferably in the maxima of the density function $\rho(r)$, the latter having been introduced only for explaining the diffraction from the wave point of view. Nor would it be reasonable to say that the matter waves which give rise to the aforementioned wave density $\rho(r)$, change their momenta and energies in such finite steps as were postulated in the corpuscular interpretation.

In contrast to the two independent interpretations of the "Camel message," however, the two interpretations $\rho(r)$ and $\sigma(p)$ of the optical message are mathematically dependent. The purpose of quantum theory is to find the mathematical rules for calculating the density function ρ when its complementary abundance function σ of the momenta is given, and *vice versa.* In fact, quantum theory gives direct mathematical relations between the density *amplitude* $\psi(r)$ and the abundance *amplitude* $\chi(p)$ whose absolute squares are $|\psi|^2 = \rho$, $|\chi|^2 = \sigma$. In the case of free particles (plane waves) each is a Fourier expansion of the other:

$$\psi(r) = \int \chi(p) \cdot e^{\frac{2i\pi}{h}(p \cdot r)} dp \text{ and its inversion.}$$

$$\chi(p) = \frac{1}{h}\int \psi(r) \cdot e^{\frac{-2i\pi}{h}(p \cdot r)} dr$$

But are there not many instances where the corpuscular interpretation of the ψ-function actually works in spite of the objections raised above? Indeed, the corpuscular interpretation of ψ works in describing *macroscopic* observations, for instance, in describing the structure of an interference pattern on a screen. The wave function ψ of the light amplitude predicts the time average of the intensity distribution on the screen with its maxima and minima; but the enumerable scintillations observed on the screen at low intensity comply indeed with the corpuscular interpretation of ψ. All this holds, however, only to a very limited extent. It is true that far away from the microscopic sources, in regions of small curvature, both the corpuscular and the wave theory are capable of explaining the macroscopic distribution of intensity—as far as *averages* in time are concerned. The relative fluctuations of the intensity, however, depend on the absolute magnitude of the intensity. Only if the latter is small is it true that one obtains relative fluctuations *as though* the ray consisted of a shower of particles, namely, scintillations and sudden registrations of Geiger counters. At large absolute intensity, however, one finds fluctuations of a quite different type known as interference fluctuations, as though the ray consisted of waves.

It is only because both classical theories are capable of describing *averages* of the intensity that one can proceed in the following two ways. (1) Calculate the average intensity by means of the wave theory (ψ-function); then, if its absolute value is small, calculate its fluctuations in a corpuscular way. This calculation gives then the impression as though the wave function ψ were "in reality" only a probability amplitude for particles. (2) Or proceed as follows: Calculate the average intensity by means of the corpuscular theory; then, if the absolute value of the intensity is large, calculate its fluctuations from interferences of waves. This calculation suggests, then, to consider the rays as consisting "in reality" of waves. How fallacious it is to believe in either of these interpretations is seen from the fact that at intermediate intensities the fluctuations follow a law which is neither corpuscular nor wave-like but is a compromise between both of them (Einstein's fluctuation formula).

I hope to have shown in the first part of these considerations that the usual corpuscular interpretation of Schrödinger's ψ-function rests upon an unjustified overinterpretation of the observed facts, in contrast to the basic idea of quantum theory, which is the idea of complementarity. In the second part I tried to point out that, although the corpuscular interpretation is working in the case of small intensities, it represents only a very limited point of view in describing what is observed in reality.

OBITUARY

SARA GWENDOLEN ANDREWS

On December 13, 1936, there passed away a woman with the rare gift of genius, Mrs. Ethan Allen Andrews, the wife of Professor E. A. Andrews, of Johns Hopkins. Mrs. Andrews, born Sara Gwendolen Foulke, died suddenly of a heart attack at her home in Baltimore. She had lived a retired life for years and many biologists in recalling her personally must go back to the memory of the beautiful, gracious young woman who made such a charming figure in the Woods Hole circle of the early 1890's.

Mrs. Andrews was born at Bala Farm in Pennsylvania in 1863. She studied at private schools and later for a time at Bryn Mawr, the University of Pennsylvania, Woods Hole and Roscoff on the French coast. She was married to Professor Andrews in 1894. Her earlier investigations dealt with infusoria and rotifers, but she became deeply interested in the structure and habits of protoplasm in general. And this is the theme of her classic memoir, "The Living Substance as Such: and as Organism," published as a special supplement of the *Journal of Morphology* in 1897, a memoir which carried her name and aroused admiration in biological circles throughout the world.

"The Living Substance" is not a paper with a definite contribution of fact or relationship between facts to be laid away after its essence has been incorporated in the handbooks. It is that and more. It has both depth and a grasp of many ideas. And one can read to advantage and with pleasure to-day this record of the multifarious experiences of a very thoughtful mind and a remarkable pair of eyes, aided by the best microscopic equipment of the time, in an exploration of the appearance and behavior of living protoplasm in protozoa, myxomycetes, leucocytes of invertebrates, sea-urchin and starfish embryos, fish eggs and other things.

The living substance, because of its tendency to take up water, exhibits itself to us as a Bütschli-structure, having the form of an emulsion, but it is only the continuous substance, separating and surrounding the droplets of included material, water and other things, that is alive. This is constantly active and its behavior is pictured as leading to changes in the general appearance of protoplasm. The alveoli, containing the discontinuous non-living stuffs, are increased or diminished in size or rearranged with the production of thin membranes, pellicles, within a protoplasmic mass or at its surface, constituting in the latter location a cell membrane. The thin lamellae between the alveoli may burst and disappear or their substance may "crawl or flow away," thinning and breaking in places and thickening elsewhere, or it may flow out at the surface of the mass or into the alveoli in the shape of delicate filose pseudopods forming in some cases new lamellae, one series of such changes in what Martin Heidenhain ("Plasma und Zelle," 1907) has called the architectural structure of cytoplasm culminating in cell division.

The histological section of this notable work is followed by a survey of the various phenomena of living nature as exhibited by individual organisms, all looked on as the outcome of the activities of substances, species-plasms or idioplasms, conceived of as isomorphic, everywhere differentiative and directive, and not optically analyzable. But while the potential features of a species are not localized within its idioplasm, the latter may transform itself into visible intra-cellular differentiations of many kinds for the discharge of particular functions. All these are designated "substance organs." Whether such ideas are tenable time and the future history of our present concept of genes as persistent and self-perpetuative entities will show. However that may be, the reader turning the pages of this memoir, now forty years old and which did not come into its own at once but encountered some inept criticism, will readily recognize, employing the words of von Baer, that we have here "observations and reflections" of genius.

H. V. Wilson

RECENT DEATHS

The death at the age of sixty-one years is announced of Dr. H. B. Carey, professor of materia medica, botany and pharmacognosy and dean of the College of Pharmacy at the Medical Center, San Francisco.

Dr. Geoffrey M. James, formerly professor of chemistry at the University of Pennsylvania, died on February 17 as the result of an automobile accident. He was forty-five years old.

Dr. Henry M. Chance, mining and consulting engineer of Philadelphia, from 1874 to 1884 assistant state geologist of the Pennsylvania Geological Survey, died on February 19. He was eighty-one years old.

DR. THOR ROTHSTEIN, formerly professor of neurology at Rush Medical College, Chicago, died on February 20 at the age of seventy-two years.

RICHARD C. MCGREGOR, the managing editor of *The Philippine Journal of Science*, died on December 30 at the age of sixty-five years. He served for many years as ornithologist of the Bureau of Science and made numerous trips through the Philippines collecting specimens of birds. He wrote a number of articles on birds and bird life. His two-volume monograph and check list of Philippine birds are standard works.

SCIENTIFIC EVENTS

TOUR OF EUROPEAN INDUSTRIAL LABORATORIES UNDER THE AUSPICES OF THE NATIONAL RESEARCH COUNCIL

A TOUR of European laboratories in England, Germany and France for leaders in industry and banking from all sections of the United States has been arranged under the direction of the Division of Engineering and Industrial Research of the National Research Council, of which Maurice Holland is the director; Dr. Vannevar Bush, of the Massachusetts Institute of Technology, is the chairman, and Howard A. Poillon, of New York, is the vice-chairman.

According to present preliminary plans, the group will sail from New York on May 14 on the *S. S. Champlain*. While in Europe this delegation of American business leaders will visit the scientific research laboratories of private industry representing eighteen major fields, as well as the laboratories of governments, universities and trade associations.

This is the fourth educational tour of research laboratories conducted by the division for American executives. The other three projects, which were participated in by many business leaders, were tours to industrial and university laboratories in the United States. These were held in 1930, 1931 and 1935 under the direction of Mr. Holland.

While preliminary plans for the European tour have been under way for several years, details and the final program will be worked out by an advisory committee composed of industrialists and bankers who were members of the past tours. Invitations for the trip are now being sent to industrialists and bankers who are interested in research.

While in Europe organizations such as the Department of Scientific and Industrial Research in England, the Verein Deutscher Ingenieurs in Germany, the Sorbonne in France and others will be hosts. Membership in the party will be limited to a hundred in accordance with the request of several of the European engineering and scientific groups.

Members of the executive committee of the Division of Engineering and Industrial Research of the National Research Council are: Carl Breer, V. Bush, F. O. Clements, Galen H. Clevenger, E. S. Fickes, R. C. H. Heck, Frank B. Jewett, Fred Lavis, F. B. Llewellyn and Howard A. Poillon.

THE NORTH CAROLINA MEETING OF THE AMERICAN CHEMICAL SOCIETY

THE annual meeting of the American Chemical Society will be held at the University of North Carolina from April 12 to 16. Programs will be presented for all divisions except Fertilizer Chemistry, the History of Chemistry, Leather and Gelatin Chemistry and Petroleum Chemistry. The preliminary program gives the following details:

The Division of Agricultural and Food Chemistry will meet all day Tuesday in joint session with the Divisions of Biological Chemistry and Medicinal Chemistry in a Symposium on the Vitamin B Complex. On Wednesday afternoon, the same divisions will cooperate in a Symposium on Vitamins Other than Those of the B Complex. On Wednesday morning, the Division of Agricultural and Food Chemistry alone will hold a Symposium on Flavors in Foods and Food Products and on Thursday morning a session for the presentation of general papers. The divisional luncheon will be held Thursday noon.

The Division of Biological Chemistry joins with the Divisions of Agricultural and Food Chemistry and Medicinal Chemistry in a Tuesday Symposium on the Vitamin B Complex and a Wednesday afternoon program on Vitamins Other than Those of the B Complex. On Wednesday and Thursday mornings divisional papers on other subjects will be presented.

The Division of Cellulose Chemistry will have a general symposium on Tuesday covering the present-day knowledge in certain fields of cellulose chemistry; the fields to be covered are not yet defined. General papers will be given in two Wednesday sessions.

The Division of Chemical Education will hold three sessions for the presentation of general papers, including an informal colloquium on the teaching of qualitative analysis.

The Division of Colloid Chemistry may cooperate with the Division of Cellulose Chemistry in its Tuesday symposium on present-day knowledge in certain fields of cellulose chemistry. On Wednesday two sessions will be held for presentation of general papers.

The Division of Gas and Fuel Chemistry will present a general program in two sessions.

The Division of Industrial Engineering Chemistry expects to schedule a large number and wide variety of general papers.

The Division of Medicinal Chemistry will join with the Divisions of Agricultural and Food Chemistry and Biological Chemistry on Tuesday in a Symposium on the Vitamin B Complex and on Wednesday afternoon in a

program on Vitamins Other than Those of the B Complex. General papers will be presented on Wednesday and Thursday mornings.

The Microchemical Section will hold one session for the presentation of general papers.

The Division of Organic Chemistry plans a program of miscellaneous papers in three sessions.

The Division of Paint and Varnish Chemistry has scheduled two sessions of general papers. A Symposium on Synthetic Plastics, under the chairmanship of Gordon M. Kline, will be held on Wednesday morning and afternoon and Thursday morning.

The Division of Physical and Inorganic Chemistry will hold a general Symposium on the Chemistry of Solid Surfaces, a half day of group symposia and probably three other sessions for general papers.

The Division of Rubber Chemistry will meet in three sessions for the presentation of miscellaneous papers.

The Division of Sugar Chemistry will hold two sessions, at which general papers will be given.

The Division of Water, Sewage and Sanitation Chemistry will meet on Tuesday for a program of general papers.

AWARDS OF THE AMERICAN INSTITUTE

Two awards of the American Institute of the City of New York for 1937—the Gold Medal to the Bell Telephone Laboratories, and a fellowship to Watson Davis, director of Science Service, Washington, D. C. —were made at the annual dinner of the institute on February 4.

Robert T. Pollock, president of the institute, presided and presented the awards. President Karl T. Compton, of the Massachusetts Institute of Technology, spoke on the work of the Bell Telephone Laboratories, and Dr. Frank B. Jewett responded. G. B. Parker, editor-in-chief of the Scripps Howard Newspapers, spoke on the work of Science Service, and Mr. Davis responded.

The gold medal, given annually in recognition of outstanding accomplishment in research, went to the Bell Telephone Laboratories "for research in electrical science which, applied to communication, have promoted understanding, security and commerce among peoples by transmitting human thought instantly throughout the world."

The fellowship in the institute, given for outstanding service in the interpretation of science to laymen, was conferred on Watson Davis, "for interpreting to the people of the nation the rapid progress of science upon which modern civilization depends and for the organized dissemination of research findings as news."

Progressive steps in the perfection of equipment needed for the faithful transmission of speech and music over great distances was demonstrated by the use of four telephone circuits by Dr. Perrine. Two of these, one a modern long distance line, and the other a modern high quality circuit used in hook-ups for radio broadcasting, extended two thousand miles from the banquet room to Danville, Illinois, and back to a special loud speaker on the platform. Two others were synthetic circuits created to give the effect of the best lines available for transcontinental telephony in 1915 and in 1920, but now no longer used. Music and speech were sent directly to the loud speaker and then through each of these circuits in turn for comparison. The loud speaker itself, weighing some 600 pounds, was a recent development based on four integral units, each amplifying sounds of particular frequencies. Effects of differences in circuits were shown by transmitting sounds of definite pitch as well as voice and music over the various lines.

The Council on Awards of the American Institute consist of: M. L. Crossley (chairman), Calco Chemical Company; Oscar Riddle, Carnegie Institution, Station for Experimental Evolution; W. H. Carrier, Carrier Engineering Corporation; W. D. Coolidge, General Electric Company; Oliver Kamm, Parke, Davis and Company; Ward F. Davidson, Brooklyn Edison Company; L. O. Kunkel, the Rockefeller Institute for Medical Research; Clinton J. Davisson, Bell Telephone Laboratories, and Harden F. Taylor, Atlantic Coast Fisheries.

AWARD OF THE WILLARD GIBBS MEDAL TO DR. McCOY

DR. HERBERT NEWBY McCOY, known for his achievements in radioactivity and in other fields of chemical science, has been awarded the 1937 Willard Gibbs Medal of the Chicago Section of the American Chemical Society. The medal will be presented at a dinner of the Chicago Section to be given on May 21.

Dr. McCoy, who was for sixteen years a member of the faculty of the University of Chicago and who is now vice-president and director of research of the Lindsay Light and Chemical Company, Chicago, was cited as "pioneer in a greater number of fundamental discoveries than any but three or four living American chemists." According to the notice sent us:

> Independently of and simultaneously with Robert John Strutt, now Baron Rayleigh, of England, and the late Professor Bertram B. Boltwood, of Yale University, Dr. McCoy was the first to establish experimentally that radium is produced by the spontaneous transmutation of uranium. He prepared the first organic metal, tetramethyl ammonium. He and Dr. William H. Ross, now of the U. S. Bureau of Soils, were the first to recognize clearly that isotopes are chemically inseparable substances. Dr. McCoy determined the first ionization constant of an indicator as a measure of its sensitiveness, and showed how the indicator participates in a reaction. He likewise made the first determination of the secondary ionization constant of a very weak electrolyte.

The Willard Gibbs Medal, founded by William A. Converse in 1911, was named for Josiah Willard Gibbs, professor of mathematical physics at Yale University

from 1871 to 1903, whose discoveries of the phase rule and other thermodynamical laws are the bases of modern processes of petroleum refining and of other chemical industries.

The 1937 medal jury was composed as follows: Professor Joel H. Hildebrand, of the University of California; Dr. Carl S. Miner, of Chicago; Professor Julius Stieglitz and Professor Hermann I. Schlesinger, of the University of Chicago; Professor Hugh S. Taylor, of Princeton University; Professor Harold C. Urey, of Columbia University; Dr. Ernest H. Volwiler, of the Abbott Laboratories, North Chicago; Professor Harry B. Weiser, of Rice Institute; Dr. George O. Curme, of the Union Carbide and Carbon Company, New York; Dr. Irving Langmuir, of the General Electric Company; Professor Ross A. Gortner, of the University of Minnesota; Dr. Eugene C. Sullivan, of the Corning Glass Works, Corning, New York.

SCIENTIFIC NOTES AND NEWS

DR. FREDERICK G. NOVY, professor of bacteriology emeritus at the University of Michigan, has been elected an honorary member of the Société de Pathologie exotique, Paris.

DR. B. R. KIRKLIN, of the Mayo Clinic, Rochester, Minn., has been elected a corresponding member of the German Röntgen Society.

THE Duddell Medal of the Physical Society, London, has been awarded to Dr. Walter G. Cady, professor of physics at Wesleyan University.

THE honorary degree of doctor of science was conferred on Dr. Charles Gordon Heyd, president of the American Medical Association, by Temple University at its Founders' Day exercises on February 15.

THE degree of doctor of pharmacy, *honoris causa*, was conferred by the Philadelphia College of Pharmacy and Science on Dr. Thomas Parran, Jr., surgeon general of the United States Public Health Service, on the occasion of the one hundred and sixteenth celebration of Founders' Day on February 23. Dr. Parran, who gave the principal address, spoke on "The Aims of the United States Public Health Service."

AT the annual dinner in New York City of the American Institute of Mining and Metallurgical Engineers, honors for distinguished service were awarded as follows: The William Laurence Saunders Gold Medal was awarded to Erskine Ramsay, chairman of the board and general consulting engineer of the Alabama By-Products Corporation of Birmingham. The first Anthony F. Lucas Gold Medal was awarded to J. Howard Pew, president of the Sun Oil Company. George S. Rice, chief mining engineer of the Bureau of Mines, Washington, D. C., won a certificate of honorary membership in the institute. The Robert H. Hunt prize for 1937 was awarded to William Floyd Holbrook, of the U. S. Bureau of Mines, and to Thomas L. Joseph, of the Minnesota School of Mines and Metallurgy in Minneapolis. John M. Hassler, engineer of the Southern District Republic Steel Corporation, of Birmingham, Ala., won the J. E. Johnson award.

THE 1936 Lamme Medal of the American Institute of Electrical Engineers has been awarded to Dr. Frank Conrad, assistant chief engineer of the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa., "for his pioneering and basic developments in the fields of electric metering and protective systems." The medal and certificate will be presented to him at the annual summer convention of the institute, which will be held in Milwaukee from June 21 to 25. The Lamme Medal was founded as a result of a bequest of the late Benjamin G. Lamme, chief engineer of the Westinghouse Electric and Manufacturing Company, who died on July 8, 1924, to provide for the award of a gold medal annually to a member of the American Institute of Electrical Engineers, "who has shown meritorious achievement in the development of electrical apparatus or machinery."

IT is recorded in *Nature* that the council of the British Institution of Electrical Engineers has made the fifteenth award of the Faraday Medal to Professor André Blondel, of Paris. The medal is awarded not more frequently than once a year, either for notable scientific or industrial achievement in electrical engineering or for conspicuous service rendered to the advancement of electrical science, without restriction as regards nationality, country of residence, or membership of the institution.

IN addition to the Wollaston Medal, which was awarded by the British Geological Society to Professor Waldemar Lindgren, of the Massachusetts Institute of Technology, for his researches concerning the mineral structure of the earth, the following awards have been made: the Murchison Medal to Dr. L. J. Spencer, in recognition of the value of his original contributions to mineralogical science and of his services to the publication of mineralogical literature; the Lyell Medal to L. Richardson, for his contributions to the geology of the Jurassic rocks of Great Britain; the Bigsby Medal to Professor C. E. Tilley, in recognition of the value of his researches in petrological science; the Wollaston Fund to Dr. D. Parkinson; the Murchison Fund to S. H. Straw. The Lyell Fund was

divided between J. F. Jackson and Miss M. E. Tomlinson.

Officers of the American Institute of Electrical Engineers for the year beginning on August 1 have been nominated as follows: *President,* W. H. Harrison, assistant vice-president, Department of Operation and Engineering, American Telephone and Telegraph Company. *Vice-presidents:* Middle Eastern District, I. Melville Stein, director of research, Leeds and Northrup Company, Philadelphia; Southern District, Edwin D. Wood, general superintendent, Louisville Gas and Electric Company; North Central District, L. N. McClellan, chief electrical engineer, U. S. Bureau of Reclamation, Denver; Pacific District, J. P. Jollyman, hydroelectric and transmission engineer, Pacific Gas and Electric Company, San Francisco; and Canada District, M. J. McHenry, manager, Toronto District, Canadian General Electric Company, Limited. *Directors:* C. R. Beardsley, general superintendent of distribution construction, Brooklyn Edison Company, Inc.; V. Bush, vice-president and dean of engineering, Massachusetts Institute of Technology; and F. H. Lane, manager, Engineering Division, Public Utility Engineering and Service Corporation, Chicago. *National Treasurer,* W. I. Slichter, professor of electrical engineering, Columbia University.

Thomas Buckley, assistant chief engineer and surveyor of the Philadelphia Bureau of Engineering, Surveys and Zoning, has been elected president of the newly organized American Public Works Association.

Cyril S. Kimball has been elected to succeed Dr. Foster Dee Snell as honorary secretary of the American Section of the Society of Chemical Industry. Dr. Snell served as honorary secretary for over ten years.

Dr. Edward Hiram McAlister, of the Oregon State College, having reached the age of seventy years, has retired with the title professor emeritus of mathematics. He has been connected with the Oregon State System of Higher Education for forty-six years.

Dr. Lee Foshay, associate professor of experimental bacteriology, has been appointed professor of bacteriology and head of the department in the College of Medicine, University of Cincinnati, in the place of the late Dr. William B. Wherry.

Dr. W. J. de Haas, professor of physics and meteorology at the University of Leyden, has been appointed Scott lecturer at the University of Cambridge for the next academic year.

Dr. John Stirling Young, professor of pathology in Queen's University, Belfast, has been appointed Regius professor of pathology in the University of Aberdeen, in place of Professor Theodore Shennan, who has resigned.

R. W. James, reader in experimental physics at the University of Manchester, has become professor of physics in Capetown, South Africa. He has been associated with Professor W. L. Bragg in the study of the structure of crystals.

B. J. Martles, assistant lecturer in zoology at the University of Bristol, has been appointed to the chair of biology at the University of Otago, New Zealand.

Dr. Kenneth F. Maxcy, professor and head of the department of preventive medicine and public health at the University of Minnesota, has been elected scientific director of the International Health Division of the Rockefeller Foundation. The appointment, which became effective on January 1, is for three years.

Dr. George H. Godfrey, formerly of the Pineapple Canners' Experiment Station at the University of Hawaii, has been appointed plant pathologist at the Texas Agricultural Experiment Station at Weslaco, not at the University of California as stated in the issue of Science of February 12.

Philip C. Staples, president of the Bell Telephone Company of Pennsylvania, has been elected president of the Franklin Institute of Philadelphia. He succeeds Nathan Hayward, who resigned recently but continues as a member of the board of managers.

N. B. Kinnear and Dr. H. A. Baylis have been appointed to deputy keeperships in the department of zoology of the British Museum.

The Rockefeller Foundation has awarded a two-year grant of $10,000 to Professor James Franck, of the Johns Hopkins University, for research in photosynthesis and photo-observation.

Dr. Victor G. Heiser has left for a five-months' tour of Africa. He will visit leper colonies and investigate the possible spread by airplane travel of yellow fever.

Dr. Maurice Stacey, of the staff of Professor W. N. Haworth, director of the department of chemistry of the University of Birmingham, England, is visiting the laboratories of the department of medicine of the College of Physicians and Surgeons, Columbia University, and the Presbyterian Hospital, New York, to engage in immunochemical studies.

Dr. G. J. Hucker, chief in research in bacteriology at the New York State Experiment Station at Geneva, has been granted six months' leave of absence to accept an invitation from the Government of New Zealand to spend four months in the Dominion conferring with bacteriologists, experts in dairy problems and veterinarians on a research program on the detection and control of mastitis and septic sore throat. Dr. Hucker will leave Geneva about July 1 and will divide his time between the University of Hamilton, the Veterinary

Laboratory at Wallaceville and the Dairy Research Institute at Palmerston North.

Dr. Hermann Fischer, a son of Dr. Emil Fischer, professor of inorganic chemistry at the University of Basle, Switzerland, recently spent a week at the University of Toronto. On February 15 he gave a lecture before the Biochemical Society and on February 19 he spoke before the Chemical Society.

The William Potter memorial lecture was delivered on February 11 by Dr. Henry A. Christian, Hersey professor of the theory and practice of physic at the Harvard Medical School. His subject was "The Fruition of a Clinician."

DISCUSSION

THE HEN'S EGG NOT FERTILIZED IN THE OVARY

It is a well-known fact that the hen may continue to lay fertile eggs for two or three weeks or even longer after isolation from the inseminating male. Since it is rarely possible to recover normal, living spermatozoa a day after insemination (Barfurth, Lau, Anderson[1]) Iwanow[2] was led to consider the possibility of synchronous fertilization of a whole clutch of growing oöcytes *within the ovary*. Experimentally he found that hens would lay fertile eggs despite a thorough flushing of the body cavity and the oviduct with an appropriate spermicide. Walton and Whethan[3] were able to corroborate these results in that a lavage of the body cavity and of the oviducts of inseminated hens with such excellent spermicides as hexyl resorcinol or formaldehyde (Voge[4]) did not prevent the subsequent laying of fertile eggs. Nevertheless, these authors were loath to accept Iwanow's explanation of their results on the ground that spermatozoa can hardly be expected to pierce the thick capsule overlying the smaller oöcytes. This contention seems most reasonable.[5] Walton and Whethan furthermore point out that in these "Iwanow" experiments sperms hidden among the folds of the oviduct may well escape contact with the spermicidal lavage.

As the matter stands, therefore, it would seem that preovulatory fertilization in the bird is far from established so far as the foregoing experiments are concerned. It appears to the writer, however, that genetic proof against the Iwanow theory is already existent in the extensive data presented by Warren and Kilpatrick's experiments[6] on fertilization in the domestic fowl. These workers exposed laying hens alternately to males of different strains, all of which possessed dominant characters readily recognized in the chicks at an early stage of development. Thus, for example, in one series, eleven hens were penned with White Leghorn males for 21 days, then with Black Minorcas for 21 days, then again for a similar period with White Leghorns and so on. The results showed that in some cases as early as the second day after changing males the eggs laid had been fertilized by sperms from the replacing male. There was practically no overlapping of the offspring. The conclusion seems inevitable that the clutch of eggs were *not* coincidently fertilized in the ovary.

Harper[7] expressed the opinion that in the pigeon the ripe oöcyte about to rupture from its greatly attenuated follicle might be fertilized in this condition, since the wall is at this time but 3.5 μ thick. But even this seems unlikely, since the egg laid by the hen as much as 24 hours after insemination is always infertile, as has been known for over a century (Coste).

Carl G. Hartman

Department of Embryology,
Carnegie Institution of Washington,
Baltimore

[1] W. S. Anderson, *Ky. Agric. Exp. Sta. Bull.* No. 239, 1922.

[2] E. Iwanow, *C. R. Soc. Biol.*, Paris, 91: 54, 1924.

[3] A. Walton and E. O. Whethan, *Jour. Exp. Biol.*, 10: 204, 1933.

[4] C. E. B. Voge, "The Chemistry and Physics of Contraception," Jonathan Cape, London, 1933.

[5] *Cf.* G. W. Bartelmez, *Jour. Morph.*, 23: 269, 1912.

[6] D. C. Warren and L. Kilpatrick, *Poultry Science*, 8: 237, 1929.

[7] E. H. Harper, *Am. Jour. Anat.*, 3: 349, 1904.

STRUCTURAL CONTROL OF THE FORM AND DISTRIBUTION OF SINK-HOLES

Malott's work[1] on Indiana caves shows interesting relations between subsurface forms and surface drainage; structural control of caves is shown remarkably well in McGill's treatise[2] on the Virginia Caverns. Martel's monumental work[3] is profusely illustrated with maps and cross-sections, many of which also show structural control, and Martel emphasizes energetically the tectonic influence in the development of sink-holes and caves, citing many instances of origin on fracture lines. However, specific reference to structural control in the form and distribution of sink-holes has escaped the present writer's notice.

[1] Clyde A. Malott, "Handbook of Indiana Geology," Indiana Division of Geology, Indianapolis, pp. 94–98, 187–210, 233–247, 1922; also several papers in the *Proceedings of the Indiana Academy of Science*, notably in Vol. 38, pp. 201–206, 1928 (1929).

[2] W. M. McGill, Virginia Geological Survey Bulletin 35, 1933.

[3] E. A. Martel, "Nouveau Traité des Eaux souterraine," Paris, Chapter 2, 1921.

In 1933 while engaged in field work, preliminary the building of the Norris Dam by the Tennessee alley Authority, the writer noticed instances of bvious control of sink-hole form and distribution. n certain outcrop areas of the soluble zones of the Knox dolomite, where the dips were in the neighborood of ten degrees and where the drainage water ound inlet along the bedding planes, sink-holes showed he tendency to migrate down-dip. The form resulting as observed to be an unsymmetrical sink-hole, steep, nd rock-walled in the down-dip direction, more gently loping and soil-covered on the opposite side. Usually light elongation in the strike direction was apparent. Several such forms were observed in the interstream pland between the Clinch and Powell Rivers near heir confluence.

In more steeply dipping rocks the unsymmetrical profile was not apparent, but the tendency toward elongation in the strike direction was noticeable. The Ordovician limestones in the Buffalo Creek valley near Loyston, dipping twenty-five degrees to thirty degrees, howed not only elongation along the strike but alignment of sink-holes along the outcrop.

Observations of this nature have practical as well as physiographic value. The Buffalo Creek valley is a subsequent form and southwest of Loyston a very low divide separates northeast from southwest surface drainage. Some evidence is present to indicate the divide is shifting, or has recently shifted. The alignment of sink-holes, along the strike and across the divide, raised the perplexing question whether the division of subsurface drainage necessarily coincided with the division of surface waters, and, in practical engineering terms, whether an impounding dike at the divide would show subsurface leakage.

A. C. SWINNERTON

ANTIOCH COLLEGE

A METHOD OF DISPERSAL OF THE BLACK WIDOW SPIDER

GENERAL interest attends current mention or discussion of the black widow spider. The present note is prompted by an artificial though probably not uncommon means of this spider's dispersal that recently came to my attention.

On November 1, 1935, a lad, Richard Tortorice, of Albany, brought to the Office of Zoology at the New York State Museum a well-fed female example of *Latrodectus mactans,* which, he reported, had been taken from a box of California grapes the same day. The lad retained the spider in a glass jelly jar at the local high school, feeding it at intervals with flies, until December 3, when he returned it permanently to the museum.

We maintained the spider in an apparently healthful condition by supplying her with cockroaches and water from a saturated pledget of cotton until January 9, 1936, when she died. On the night of December 22, 1935, the spider attached a cocoon to the under side of the wire gauze covering the jar, but spiderlings never issued from it.

Perhaps the most interesting fact in this enumerated chain of events was the successful consummation of a railroad journey from California to Albany, New York, by this particular black widow spider. It affords still another illustration of the dispersal of a species by man-made devices. Had the spider been freed under more salubrious climatic conditions she might well have been responsible for the establishment of the species in that locality and a different story might have been associated with this importation.

DAYTON STONER

NEW YORK STATE MUSEUM

CONCERNING FOSSIL LEGUMES

IN a recent number of SCIENCE,[1] E. B. Ford, I. L. Baldwin and Elizabeth McCoy expressed the hope that some paleobotanist would report observations regarding fossil nodules from the roots of leguminous plants. As these writers intimated, other fossil remains of Leguminosae, such as leaves, fruits, seeds and wood, have been reported; but there are no authentic records of fossil root nodules. The hope that such may be discovered is, I am afraid, doomed to be deferred indefinitely, because these relatively minute structures are generally delicate and evanescent and are unfavorably situated for preservation as fossils.

Only remotely analogous to leguminous rootlets and root nodules are the rhizomes and tubers of *Equisetum,* which are sometimes preserved as fossils.[2] These survive because they are composed of fairly resistant tissues and because they grow along banks of streams or the edges of marshes where, when detached, they are likely to be buried in sediments and subjected to the processes of fossilization.

Fossil objects that have sometimes been regarded as underground leguminous fruits, like peanuts, are those called *Leguminosites? arachioides* Lesquereux[3] and *L. a. minor* Berry.[4] I propose in a paper now being prepared to present evidence that these objects are not legumes, but the fruit pods of an extinct trochodendraceous group of plants having *Populus*-like leaves and producing small winged seeds.

ROLAND W. BROWN

U. S. GEOLOGICAL SURVEY

[1] SCIENCE, 85: 45, 1937.

[2] Oswald Heer, *Flora fossilis arctica,* 2(3): 31, pl. 1, figs. 1–15; pl. 2, figs. 1–4, 1870. Leo Lesquereux, U. S. Geol. Survey Terr. Rept. 7: 67, pl. 6, figs. 2–4, 1878.

[3] Leo Lesquereux, *idem.,* p. 301, pl. 59, figs. 13, 14.

[4] E. W. Berry, U. S. Geol. Survey Prof. Paper 156: 89, pl. 14, figs. 2–6, 1930.

THE NATIONAL ASSOCIATION OF SCIENCE WRITERS

THROUGH a regrettable oversight, I neglected to include the name of Allen Shoenfield, of the *Detroit News*, in the list of charter members of the National Association of Science Writers in my recent address before the American Association for the Advancement of Science. I trust that all those who turn to the published address, "Science and the American Press," SCIENCE, January 29, for the complete membership of the National Association of Science Writers will add the name of Mr. Shoenfield.

DAVID DIETZ

CLEVELAND, OHIO

REPORTS

GEOLOGICAL SURVEY OF NEWFOUNDLAND REVIVED

OFFICIAL geological surveys of the island of Newfoundland were begun as early as 1839 (James Beete Jukes, 1839–40) and carried out intensively by a small personnel for half a century (Alexander Murray, 1864–1883; James P. Howley, 1869–1909; Dr. Herbert A. Baker, 1926–1929). The advances in the science of geology since the pioneer work was performed are so great and the need of up-to-date information on the mineral resources so pressing, however, that on its induction into office in 1933 the new Commission of Government, appointed by the British Crown, authorized the resumption of the Geological Survey by a Geological Section of the Department of Natural Resources.

The nucleus of the staff of the Geological Section consists of two Newfoundlanders: Dr. A. K. Snelgrove, assistant professor of geology in Princeton University, was appointed government geologist, and Mr. C. K. Howse, B.Sc., assistant government geologist. Dr. Snelgrove continues in his Princeton position, also.

Following the recent practice of the Geological Survey of Canada and of Surveys in Crown Colonies, the field work of the Geological Section is devoted primarily to investigations in economic geology, designed to foster the mining industry. The reports on this work are issued as a series of bulletins, the purpose of which is to provide a scientific foundation for mineral exploration and exploitation. Areal studies in particular are yielding fundamental data on the structure, stratigraphy and petrogenesis of this most northeasterly part of the Appalachian Mountain System of North America. For the benefit of prospectors, areal geological sheets are distributed separately, with a simple description of the character and manner of occurrence of economic mineral deposits known or likely to be present. Already published are the results of surveys of chromite and gold deposits by the Government Geologist, and of two areal geological studies in cooperation with the Department of Geology of Princeton University: The Bay of Exploits area, by Dr. G. R. Heyl, and the Southern Half of the Bay of Islands Igneous Complex, by Dr. J. R. Cooper. A bibliography of Newfoundland geology, 1818–1936, by Rachel M. Betts, Guyot Hall Library, Princeton University, forms Bulletin No. 5, which was issued recently.

In the past field season an unusually comprehensive program of geological mapping was carried out, with the assistance of a temporary staff of a score of geologists in the areas represented in Fig. 1. Geodetic control is being provided for the topographical base maps by a five-year geodetic survey program now in progress in cooperation with the Geodetic Service of Canada under a grant from the Colonial Development Fund.

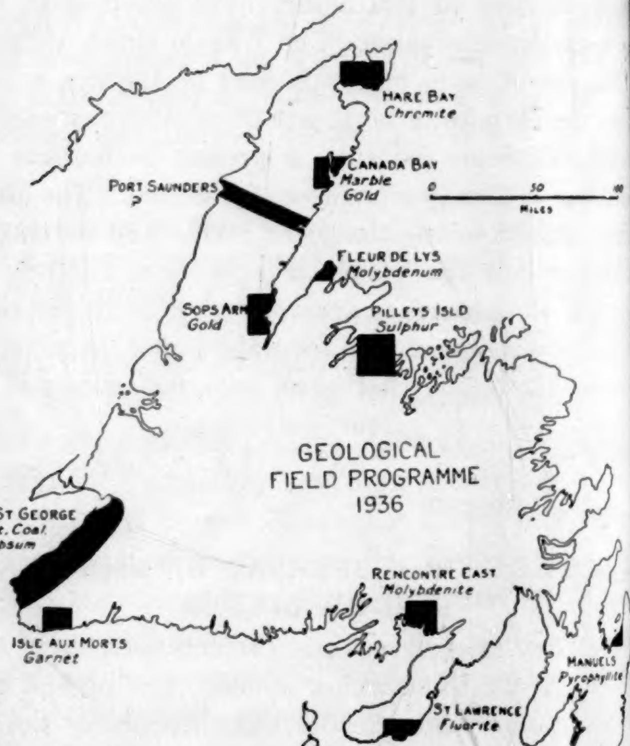

FIG. 1. Newfoundland geological map areas, 1936.

As Princeton University Geological Expeditions have been sent to Newfoundland intermittently since 1911, and fourteen Princeton contributions to the geology of the island have already been published, it is natural that a majority of the geologists called in on this expanded government work were from Princeton. However, the faculties or student bodies of seven other American and Canadian universities were also represented. Notable members of the temporary and

nsulting staffs include: Professor G. W. Bain, of nherst College, who studied the promising marble posits of Canada Bay and Sops Arm; Professors 0. Hayes and H. Johnson, of Rutgers University, o investigated the Bay St. George Carboniferous ea; Professor B. F. Howell, of Princeton University, thority on Cambrian formations; Professor W. H. venhofel, chairman of the Department of Geology the University of Wisconsin, authority on Silurian cks. In addition ten Princeton geologists, chief nong whom were Professor A. F. Buddington, chairn of the Department of Geology, Professor E. mpson and Dr. H. H. Hess, engaged in faculty rearch, consultation to mining companies or collection data for theses.

Through the participation of Mr. J. W. Sullivan, aduate student at Yale University, the studies in the ology of the west coast made by four Yale expedins since 1910 were continued.

The Geological Section also acts in an advisory pacity to the Labrador Mining and Exploration mpany, Ltd., holders of a mineral concession of over ,000 square miles in Newfoundland Labrador, on ich extensive work was begun last summer and is be continued for a number of years.

The present geological activities are being followed by prospecting and exploration by local, Canadian, nited States and English interests, and it is anticited that a number of the campaigns now in progress ill yield tangible results in the form of development latent resources and afford some amelioration of the onomic difficulties which confront Newfoundland.

A. K. SNELGROVE

PRINCETON UNIVERSITY

THE THIRTY-THIRD MEETING OF THE ASSOCIATION OF AMERICAN GEOGRAPHERS

THE American Geographers met in Syracuse, N. Y., their thirty-third annual meeting on December 31, 936, and January 1 and 2, 1937, Professor William erbert Hobbs, of the University of Michigan, presint of the association, in the chair. The meetings ere exceptionally well attended, and the papers prented aroused a great deal of interest and discussion. The secretary, Preston E. James, of the University f Michigan, had constructed the program about sevral major themes. Among them were: "North Amera, the Northeast," four papers; "South America," o papers; "The Classification and Use of Soils," ur papers; "North America, Urban Studies," five apers; "North America, the Western Mountains," x papers; "Polar Exploration," seven papers; North America, the Appalachians and the South," six apers; "North America, Climatic Studies," four papers; "The Far East," four papers, and "Europe," four papers.

A memorial to the late Oliver L. Fassig; a special symposium on "Problems in the Cultural Geography of North America" for the members only; an illustrated lecture on "Kano," one of the principal centers of life in the Sudan, by Derwent Whittlesey, of Harvard University; the annual banquet, at which Acting Chancellor William P. Graham welcomed the membership to Syracuse University, the award for studies in physical geography was announced and President William Herbert Hobbs delivered his presidential address on "Discovery and Exploration within the Arctic Circle"; a number of desultory but valuable papers, not directly related to the group papers, completed the program. The arrangement of papers in selected fields expedited discussion by concentrating interest upon those fields and enabled the presiding officer to run the program quite on schedule.

Among the studies which elicited most discussion and interest were: "Season of Birth, and the Distribution of Civilization," by Ellsworth Huntington; three papers dealing with erosion surfaces and the physiographic evolution of the Rocky Mountain region by the Wallace W. Atwoods, of Clark University, father and son, who have made that region their major field of research these many years; "An Optical Phenomenon and Its Relation to the Discovery of Polar Lands," whereby William H. Hobbs submitted his arguments that the long-sought "Crocker Land" of the Arctic Ocean may still remain to be discovered though farther at sea than has been supposed, and that the mapping of land in the Antarctic by Wilkes and others where no land has since been shown to exist can be fully explained by a peculiar form of mirage; "Lower Mississippi Valley Loess," in which Richard Joel Russell, of Louisiana State University, implied a residual genesis for some of the deposits bordering the Mississippi Delta, and the groups of papers on soils, the Far East and Europe. A particularly valuable paper by W. L. G. Joerg, of the American Geographical Society, "The Geography of the Antarctic: The Advances of a Decade, 1926–1936," summarized a field which has been prominent in public news and attention for many years.

A noteworthy feature of the banquet program was the first award of the fund for research in physical geography, recently established by Wallace W. Atwood, of Clark University, formerly president of the Association of American Geographers, to Richard Joel Russell, of Louisiana State University, in recognition of his meritorious original investigation of a number of problems in physical geography and in approval of a special study of the Volga delta to which he plans to devote the funds. The fund will be administered

by the executive council of the association and awarded, at intervals, whenever, in its opinion, an outstanding project is proposed by some member of the association who has already achieved notable results in original research.

The officers chosen for the ensuing year are: *President,* W. L. G. Joerg, of the American Geographical Society, New York; *Vice-President,* Guy-Harold Smith, Ohio State University, Columbus; *Secretary,* Preston E. James, University of Michigan, Ann Arbor; *Treasurer,* John E. Orchard, Columbia Unive sity, New York; *Editor,* Derwent Whittlesey, Ha vard University, Cambridge, Mass. The councilo are: C. C. Colby, University of Chicago; William Hobbs, University of Michigan; Kirk Bryan, Harva University; Richard Joel Russell, Louisiana State U versity, and Richard Hartshorne, University Minnesota.

The executive council has decided upon Ann Arbo Michigan, as the place of the next annual meeting.

SPECIAL ARTICLES

LOCALIZED CORTICAL GROWTH AS THE IMMEDIATE CAUSE OF CELL DIVISION

CHAMBERS[1] supports the theory that cell division is caused by the growth of two viscous astral spheres separated by a liquid zone, in combination with a probable change in surface tension. Gray[2] thinks the growing asters displace fluid peripheral cytoplasm to the walls of the furrow, where cleavage occurs apparently because the fluid material is reduced in amount by conversion into the more viscous substance of the aster (see especially his figure 92). Spek[3] assigns the dominant rôle to an increase of surface tension in the region of the furrow and to the subsequent flow of peripheral cytoplasm into the furrow. Heilbrunn[4] is inclined to the view that astral rays "pull on the surface membrane of the cell" (p. 272).

In an analysis of the surface kinetics of the cleaving amphibian egg, I have obtained results which point to a mechanism different from any of the above. Vogt's method of localized vital staining,[5] in combination with a study of serial sections, was used to obtain a fairly detailed picture of the behavior of the egg cortex in the Pacific Coast newt, *Triturus torosus.* The explanation suggested seems equally applicable to certain invertebrate eggs, to judge from the recent descriptions of Motomura.[6] The main phenomena observed in *Triturus torosus* are as follows:

(1) Cleavage is initiated by a contraction of the egg cortex at the site of the future furrow. This is a contraction in the sense that the cortex becomes thicker and bulges toward the egg interior. At the same time the surface of the egg is displaced toward the site of thickening.

(2) The mid-portion of the contracted cortex begi to expand within one to two minutes after the abo contraction (at temperatures ranging from 22° to 2 C.). The pigment of this expanding portion is rea ranged in irregular streaky lines, plainly indicati that the cytoplasm is being stretched. The surface the stretched material sinks below the general egg su face much as does the surface of a fluid materi stretched between relatively firm supports. Chamber gives other evidence that this zone is liquid in his o servation of Brownian motion and his micro-dissecti experiments. The stretched cortical material ("t primary furrow") has a lower concentration of pi ment per unit surface and therefore appears light than the rest of the upper hemisphere (see Fig. 1).

(3) A secondary furrow appears at about the cent of the primary furrow. It gives evidence of addition stretching of its materials.

(4) The pigmented cortex bounding the lightly pi mented "primary furrow" becomes the site of inten growth directed toward the egg interior. Vital stained marks placed in this position are drawn o into long delicate hair-lines as the furrow deepen Only a narrow strip of the cortex adjacent to the ear furrow undergoes growth; this applies to the top (pi mented) surface of the egg (see Fig. 1). On the *low* (unpigmented) side of the egg a much wider strip cortex is involved. As surface-cortex is converted in furrow-cortex, its content of clear cytoplasm increase with a corresponding decrease in the concentration pigment and yolk "granules."

The streaming of peripheral cytoplasm from t sides of the egg into the furrow, which has been d scribed by a number of persons,[7] is noticeably abse in the cortex. The streaming observed was in all pro ability a *sub*-cortical movement only, as has been su gested by Motomura[6] also. This is supported by t recent work of Motomura[6] and of Brown[8] as well

[1] R. Chambers, in "General Cytology," ed. by E. V. Cowdry, Section V, 1924.

[2] J. Gray, "A Textbook of Experimental Cytology," chapter 9, 1931.

[3] J. Spek, *Arch. f. Entw.-mech.,* 44: 5, 1918.

[4] L. V. Heilbrunn, "The Colloid Chemistry of Protoplasm," chapter 15, 1928.

[5] W. Vogt, *Arch. f. Entw.-mech.,* 106: 542, 1925.

[6] I. Motomura, *Sci. Reports of the Tohoku Imper. Univ.,* 4th Series, 10: 212, 1935.

[7] See the works of Chambers, Gray and Spek alrea cited.

[8] D. E. S. Brown, *Jour. Cell. and Comp. Physiol.,* 5: 33 1934.

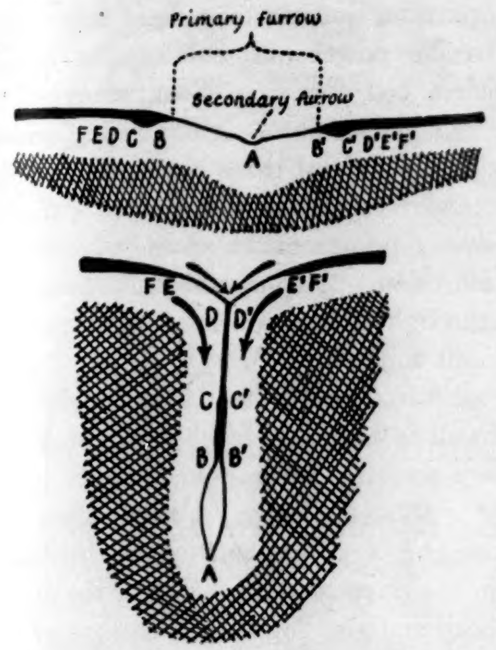

FIG. 1. Diagram illustrating the manner of cortical growth described in the text. Cortical pigment is shown as a solid black line. Remainder of cortex white. Subcortical cytoplasm cross-hatched. The top sketch represents an early stage of cleavage, the lower one a more advanced stage. Arrows indicate direction and approximate site of growth. Corresponding portions of the cortex indicated by letters A, A′, etc.

my own work which shows that the cortex (of the *Strongylocentrotus, Arbacia* and *Triturus* eggs, respectively) is a more or less rigid layer during cell division.

A reasonable explanation of the observed cortical growth, in view of its localized character, is that the increase may be due to an imbibition process, which of course does not imply that the cortex becomes "fluid." Indeed there are indications that the cortex of the furrow, excepting a small part near its tip, does not differ much in viscosity from the rest of the egg cortex. At least the difference is not great enough to give rise to the characteristic surface contours of fluids in contact with relatively solid materials. It is well known that the swelling pressure of bio-colloids may attain high values under proper conditions, and the relatively fluid material which Chambers[1] ascertained in the equatorial region of the cleaving egg would offer little resistance. It is also possible that the growth of the furrow-cortex is by intussusception of clear cytoplasm of *sub*-cortical origin; this might explain the part played by the cytoplasm which some workers have seen streaming toward the furrow. Both processes might be involved, since they are obviously not antagonistic.

This view of the mechanism of cell division has certain features in common with the sol-gel transformations generally regarded as important in the formation of pseudopodia in certain amoebae. The *protrusion* of the pseudopodium involves the localized growth of a peripheral gel cylinder at the expense of a centrally located sol. Is it a mere superficial coincidence that the *intrusion* of the cell surface seems also to involve a localized growth of peripheral cytoplasm at the expense of the more fluid elements of the cell?

Details will be published elsewhere.

A. M. SCHECHTMAN

UNIVERSITY OF CALIFORNIA AT
LOS ANGELES

HOW CONSISTENT ARE AN INDIVIDUAL'S BRAIN POTENTIALS FROM DAY TO DAY?

IN a previous article, we showed that an individual can be distinguished from other individuals by his brain potentials.[1] An important and related question left unsettled was: Are an individual's brain potentials consistent from time to time?

To answer this question, we obtained on five different days (as a rule not consecutive) an adequate sampling of brain potentials from each of 11 healthy university students (6 men, 5 women). No attempt was made to run a subject at a certain time of the day or to control in any way his daily routine of living. A strong effort was made, however, to keep the experimental conditions as constant as possible from subject to subject and from day to day for the same subject. The observer reclined on a cot in a dark and electrically shielded room. He was instructed to keep his eyes closed and his mind as "blank" as possible. The brain potentials were led off from the left occipital area by means of a surface electrode. A ground electrode was attached to the lobe of the left ear. Standard amplifiers and a Westinghouse oscillograph were used for recording.

Because of the amount of space necessary to display them, the 55 records (5 records from each of 11 subjects) were divided into three groups, two groups of 20 records each and one group of 15 records. Each group contained all the records of 3 or of 4 subjects, as the case might be. The records in each group were thoroughly "shuffled" and chosen at random for pasting on a wall. One group was studied at a time. Each record was given a number. Four of us, who had served as judges in the previous study on identification, served again here. The task was to study the mounted records and to arrange them according to their numbers into groups of five. Each group of five was to have in it all the records, and only the records, of one subject. The person comparing the records was not told whether he was wrong or right in his judgments until he had finished with an entire group of 15 or 20 records.

A total of 220 judgments were made (4×55).

[1] L. E. Travis and A. Gottlober, SCIENCE, 84: 532, 1936.

Ninety-one per cent. of the records were correctly assigned (20 errors). Three of us made 4 errors each, and one of us made 8 errors. One of us made no errors in one group of 20 records, and another of us in the other group of 20 records. One of us made no errors in either of the two groups of 20 records each. According to the law of probability, by chance one could expect to assign accurately 20 records once in 488,864,376 times, and 15 records once in 126,126 times. We feel that chance played practically no rôle whatsoever.

As was to be expected, the records of some individuals were more distinctive and consequently more easily grouped than were those of other individuals. The records of 6 of our subjects were strikingly similar and consequently difficult to classify. Such criteria as frequency, amplitude and form of the waves played their part in making accurate judgments possible. Also, we evaluated the records as a whole, considering such factors as trains of waves, stability of the base-line, and fluctuations in the frequency and amplitude of the waves. No other cues incident to photography, handling of the paper or differences in the width of the time-line could possibly contribute to the accuracy of our judgments, since always the records of *different* individuals were taken, developed and handled together. This means that cues arising from such sources would make the same individual's records unlike instead of alike.

Our conclusion is that not only can an individual be distinguished from other individuals by his brain potentials, but under relatively constant experimental conditions an individual's brain potentials are highly consistent from day to day.

LEE EDWARD TRAVIS
ABRAHAM GOTTLOBER
STATE UNIVERSITY OF IOWA

MICROSTRATIFICATION OF THE WATERS OF INLAND LAKES IN SUMMER

THE thermal stratification of temperate lakes into three general regions in summer, namely, epilimnion, thermocline and hypolimnion, has been known for many years. Recent investigations show, however, that there is also a sharply marked microstratification in the thermocline and hypolimnion which has not been found hitherto. This phenomenon was discovered by means of a new type of apparatus for measuring the transparency of water, which is similar to that employed by Hans Pettersson[1] on Norwegian fjords; it was used on several Wisconsin lakes during the past summer and gave some very interesting results, four of which are illustrated in Fig. 1.

The apparatus consists of a light source, which is a three candle power automobile light bulb, and a photo-electric cell for a receiver; each of these is mounted in a metal water-tight housing which has a flat glass window about three centimeters in diameter. The light and receiver are attached to a piece of galvanized iron pipe one meter apart, with the windows facing each other. A condensing lens immediately in front of the light focusses a beam of parallel light on the photocell window.

Insulated wires lead from the housings of the light and photocell to a wire cable which connects them with the battery and the reading instrument in the boat. The cable is 35 meters long. An amplifier, a series of resistances and a potentiometer are included in the circuit for the purpose of amplifying the current from the photocell and also for the adjustment of the micro-ammeter to any desired zero point. In its latest form a rubber hose is attached to the iron pipe for the purpose of pumping up samples of water from the different depths and also an electric thermometer for taking temperature readings. A separate light source for taking measurements of light scattering is also included.

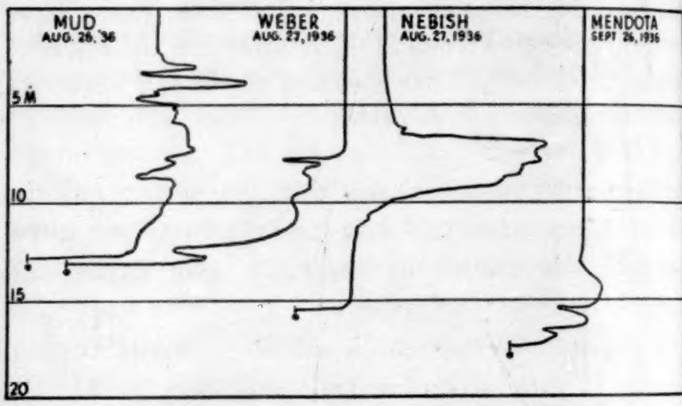

FIG. 1. Relative transparencies of the waters of four Wisconsin lakes at different depths.

The results obtained with this instrument show that the transparency is uniform throughout the upper stratum of water, or the epilimnion, which is kept in circulation by the wind (see Fig. 1). In the thermocline and hypolimnion, on the other hand, the water is stratified alternately into more transparent and less transparent layers. These layers may be only a few centimeters thick, as in Mud Lake, or they may be one or two meters thick, sometimes more. A marked decrease in transparency is always found within a meter or two of the bottom. Similar stratifications were found at different stations in the same lake, which indicates that it is not a local phenomenon.

The curve for Nebish Lake differs from the others in that a three-meter layer of water in the thermocline was more transparent than the epilimnion. In Mud

[1] H. Pettersson, *Jour. du Conseil Int. pour l'Expl. de la Mer*, 10: 1, 1935.

Lake the two layers in the thermocline that were more transparent than the epilimnion were only a few centimeters thick. In some series certain layers in the hypolimnion were more transparent than the epilimnion.

Preliminary tests show that part of the material which causes the lower transparency can be removed from the water with a high-speed centrifuge. In one case Daphnias were found in considerable numbers in the layer with low transparency; plate counts also show that bacteria are more numerous in the layers with minimum than in those with maximum transparency.

L. V. Whitney

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University of Wisconsin

SCIENTIFIC APPARATUS AND LABORATORY METHODS

USE OF THE LANTERN FOR OBJECTIVE EXAMINATIONS

This method has been used with large classes in elementary physiology in the General College and other divisions of the University of Minnesota.

At the beginning of the term each student is assigned to either an odd or an even numbered seat. Sometimes the class is merely divided into odds and evens and told to take seats accordingly. The odds are known as Division A, the evens as Division B.

Each student receives a stapled packet of about 25 mimeographed slips, 11 by 4½ inches, pink for A's and blue for B's. Students are instructed to bring these slips to lectures. The slips have space for student's name and 25 numbered blanks for answers to questions. At the top is instruction for A's to answer only "A" questions, B's only "B" questions.

Slides of ordinary type and size are used. The usual slide holder permits illumination of an area 3 by 3½ inches. Judicious whittling will increase the area exposed to 3¼ by 3½, the cover glasses being bound together only at ends. On this area six short questions can usually be typed, three A's and three B's. If questions are longer, four are typed on each slide.

The "Radio-Mat" method of typing slides is used. However, as sold, these expose an area of only 2¼ by 3 inches. We find it cheaper and more convenient to buy the red copying paper and Cellophane in letter-size sheets, cutting the copies into proper size before mounting between glasses.

Any of the ordinary objective types of questions may be used. Omission of unnecessary words and use of understood abbreviations shorten questions and increase number on each slide.

A sample slide, alternative answer type, is shown below. Students understand the symbol / as separating alternative answers and equivalent to the word "or." The same questions are given to both divisions but in different order.

A1 Conditioned reflexes investigated: Pavlov/Sherrington/Cannon/Magendie.
A2 Example involuntary non-reflex activity: constriction pupil/ciliary action/goose flesh/swallowing.
A3 Chief motor tracts cross: cerebrum/cerebellum/medulla/cord.
B1 Respiratory center located: cerebrum/cerebellum/medulla/cord.
B2 Example smooth muscle reflex: sneezing/winking/knee jerk/blush.
B3 Autonomic N.S.: wholly efferent/wholly afferent/mixed.

Teachers having lanterns for opaque projection could doubtless make direct use of typewritten questions.

A quiz may include any number of questions. We have used ten to fifty. Usually one purpose has been to take a roll call and check tardiness. Unannounced quizzes of ten questions served these purposes.

Almost no cheating has been observed. Although in adjacent seats, the odds and evens are too busy concentrating on their respective jobs.

Slides are filed for use with future classes. Usually copies of questions are posted after quizzes.

Last year we experimented with two lanterns. This method has the advantage of permitting a larger number of questions on view at a given time, "A"s on one screen, "B"s on the other. It also makes it easier to use multiple choice answers, questions on one slide, answers on the other.

Several members of the physiology staff made useful suggestions, especially Drs. Hugo Miller and Carroll Bellis.

E. P. Lyon

Medical School,
University of Minnesota

APPARATUS FOR PRODUCING CUMULATIVE AND ORDINARY TYPE KYMOGRAPH RECORDS SIMULTANEOUSLY

A quantitative representation of physiological data given by the ordinary type kymograph record would, in many instances, be of advantage, particularly so in the comparison of sets of data. A method has been described[1] by which this may be accomplished in measuring the activity of small animals. The present article presents a method applicable to a much wider range of experimentation. A simple muscle preparation will serve to illustrate the method.

[1] K. M. Wilbur, Science, 84: 2177, 274, 1936.

An oiled glass rod (R) of ⅛″ diameter forms a support for a sliding wire collar to which is attached a writing lever (L), resting against a horizontal kymo-

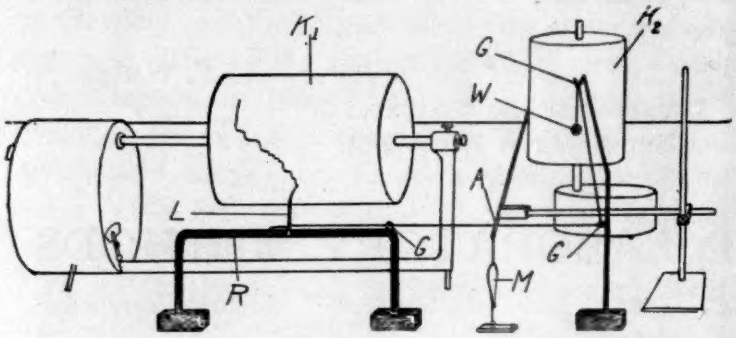

FIG. 1

graph drum (K1). Less than 50 milligrams were required to produce movement of the writing lever, even when no special precautions were taken to insure ease of movement of the sliding collar and the writing lever. A silk thread passes from the sliding collar through three glass loops (G). The thread is weighted with a small piece of plastic clay (W). The short arm of a muscle lever (A) extends over the thread. Two glass rods (not shown in figure) on either side of the muscle lever allow only vertical deflection of the thread. The contraction of the muscle (M) pulls down lever (A) causing the thread to be depressed. The depression of the thread causes the writing lever to be pulled to the right, since the weighting arrangement does not permit the other end of the thread to move. When the muscle relaxes the weight drops slightly, pulling the thread taut without further displacing the writing lever. Thus, the lever will move only during contraction, and the curve produced will be cumulative as the muscle contracts. The greater the frequency of contraction the more rapid will be the rise of the curve. The curve will also rise more rapidly if the amplitude of contraction is increased. Simultaneous with the making of the cumulative record on K1 another record of the usual type is being obtained on K2. Both the change in frequency and amplitude will be indicated in the cumulative curve, although less clearly than in the ordinary record, since each contraction is represented by a discrete step in the curve. The height of the curve at any point will be proportional to the total contraction up to that time.

By a slight modification of the apparatus records may be obtained from levers moved by rubber tambours.

K. M. WILBUR

OHIO STATE UNIVERSITY

ANOTHER CARBORUNDUM PENCIL

WE have been using in our classes a method of mounting engravers' points for marking microscope slides which seems both simpler and more satisfactory than that devised by Chatters.[1]

Glass tubing just large enough for insertion of an engravers' point is selected and cut in four-inch lengths. With the aid of heat the blunt end of a piece of carborundum is coated with a thin layer of sealing wax, and while the wax is still soft the carborundum is inserted to about half its length in one end of the glass tubing. The student's name is then written in India ink on a narrow piece of card, which is pushed into the tube far enough to avoid scorching when the open end is either fire polished or sealed.

Pieces of carborundum mounted in this way have been in use in the histology class at Yale for several years. The insertion of a name card was the idea of a student at Smith.

ESTHER CARPENTER

SMITH COLLEGE

[1] SCIENCE, 85: 128, January 29, 1937.

BOOKS RECEIVED

BUTLER, CHARLES S. *Syphilis Sive Morbus Humanus.* Pp. xii + 137. Illustrated. Science Press Printing Co. $3.00.

CHIKASHIGE, MASUMI. *Oriental Alchemy.* Pp. viii + 102. Illustrated. Rokakuho Uchida, Tokyo.

DENT, JOHN Y. *The Human Machine.* Pp. vii + 294 + v. Knopf. $2.50.

FAUNE DE FRANCE. *31, Homoptères Auchénorhynques. I.* H. Ribaut. Pp. 228. 629 figures. Paul Lechevalier, Paris.

Field Engineers Bulletin No. 10, December, 1936. Pp. 206. U. S. Coast and Geodetic Survey.

GATTERMANN, L. *Laboratory Methods of Organic Chemistry.* Revised by HEINRICH WIELAND. Pp. xvi + 435. 59 figures. Macmillan. $4.50.

SAPHIR, OTTO. *Autopsy Diagnosis and Technique; A Manual for Medical Students, Practitioners, Pathologists and Coroners' Physicians.* Pp. xx + 342. 65 figures. Hoeber. $5.00.

Science Reports of the Tôhoku Imperial University, First Series. Anniversary Volume Dedicated to Professor K. Honda, October, 1936, on the Completion of Twenty-five Years of his Professorship by his Friends and Pupils. Pp. 1,126. Illustrated. *Science Reports, Second Series, Geology.* Special Volume No. 1. Pp. 66. 59 plates. Maruzen, Tokyo.

SINCLAIR, JOHN G. *Anatomy of the Fetal Pig.* Pp. 80. 51 figures. Collegiate Press, Ames, Iowa. $2.00.

SMART, W. M. *Textbook on Spherical Astronomy.* Second edition. Pp. xii + 430. 149 figures. Cambridge University Press, Macmillan. $5.50.

Transactions of the American Philosophical Society Held at Philadelphia for Promoting Useful Knowledge. New Series, Vol. XXIX, December, 1936. *Hydrography of Monterey Bay, California; Thermal Conditions, 1929–33.* TAGE SKOGSBERG. University of Pennsylvania Press. $3.00.

Travaux et Mémoires de l'Institut d'Ethnologie, Vol. XXII, *Danses magiques de Kelantan.* JEANNE CUISINIER. Pp. 206. 4 plates. Vol. XXIII, *Nueva Corónica y Buen Gobierno.* FELIPE GUAMAN POMA DE AYALA. Pp. xxviii + 1168. Illustrated. Institut d'Ethnologie, Paris.

YOE, JOHN H. *Chemical Principles, with Particular Application to Qualitative Analysis.* Pp. ix + 311. 29 figures. Wiley. $2.75.